MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022 / 2023 (TERM ID 2210)

PEL0016 - ELECTRICITY AND MAGNETISM

(Foundation in Engineering)

8 FEBRUARY 2023
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of **FOUR (4)** printed pages excluding the cover page and appendices, with **FOUR (4)** questions.

2. Answer **ALL** questions. The distribution of the marks for each question is given.

3. Please write all your answers in the Answer Booklet provided.

QUESTION 1 (15 marks)

a) An electron traveling at 1×10^8 ms^{-1} in a plane perpendicular to uniform 0.05 T magnetic field. Calculate the force on the electron. [2 marks]

b) Two parallel wires are 10 cm apart carry currents in opposites direction. Current $I_1 = 10$ A is out of the page and $I_2 = 5$ A is into the page. Calculate:
   i) the magnetic field, B. [6 marks]
   ii) the direction of magnetic field, B. [2 marks]
   half way between the wires

c) A proton moved through a region of mutually perpendicular region of electric and magnetic field. Given electric field, $E = 1 \times 10^5$ Vm^{-1} and, electron velocity = 5.0×10^6 ms^{-1}. Calculate the magnetic field, B needed for the electron to travel undeflected through the region. [5 marks]

QUESTION 2 (15 marks)

Calculate I_1, I_2 and I_3 using Kirchhoff's Laws for the circuit in **Figure Q2**. [3 × 5 marks]

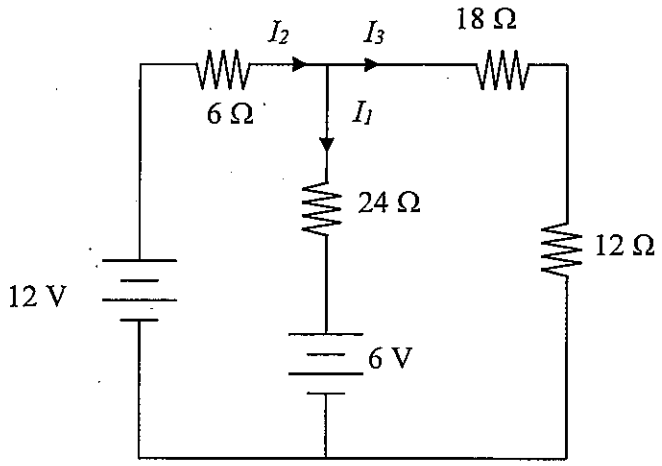

Figure Q2

QUESTION 3 (10 marks)

A 10 Ω resistor, a 4 mH inductance, and a 2 μF capacitance in connected in series. The circuit is to operate at 50.0 Hz. Calculate the:

a) impedance of resistor, R in series with capacitor C [3 marks]
b) impedance of capacitor, C in series with inductor, L [3 marks]
c) frequency at which inductor reactance and capacitor reactance is equal. [4 marks]

Continued...

QUESTION 4 (10 marks)

a) Draw the energy diagram for:
   i) Insulator [3 marks]
   ii) Semiconductor [3 marks]
   iii) Conductor [3 marks]
   At 0 K (Kelvin) on **A SINGLE** graph showing it's relative difference. Label conduction band (CB), valence band (VB), energy gap (E_g) and area occupied by electrons.

b) Identify the type of transistor in **Figure Q4(b)**. [1 mark]

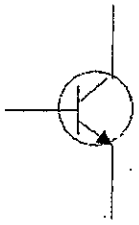

Figure Q4 (b)

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APPENDIX

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass	m_p	1.67×10^{-27} kg
Charge of electron	e	1.602×10^{-19} C
Boltzmann's constant	k_B	1.38×10^{-23} JK^{-1}
Speed of light in vacuum	c	3.0×10^{8} ms^{-1}
Acceleration due to gravity	g	9.81 ms^{-2}
Coulomb constant	k	8.988×10^{9} Nm^{2}C^{-2}
Permittivity of free space	ε_o	8.85×10^{-12} C^2(N.m^{-2})
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ Hm^{-1}

List of formulas

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \mu_0 I\left(\frac{N}{L}\right)$$

$$E = V + Ir = I(R+r)$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1 Q_2}{r^2}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

$$F = qE$$

$$F = BIL\sin\theta$$

$$F = qvB\sin\theta$$

$$F = ma$$

$$F = \frac{mv^2}{r}$$

$$F = \frac{\mu_0 I_1 I_2 L}{2\pi d}$$

$$W = qV_{BA}$$

$$E = \frac{V_{BA}}{d}$$

$$Q = CV$$

$$C = \frac{\varepsilon_0 A}{d}$$

$$E = \frac{Q}{\varepsilon_0 A}$$

$$Q = It$$

$$V = IR$$

$$R = \rho\frac{L}{A}$$

$$P = IV = I^2R = \frac{V^2}{R}$$

$$W = VIt$$

$$V_1 = V_T\left(\frac{R_1}{R_1+R_2}\right)$$

$$I_1 = I_T\left(\frac{R_2}{R_1+R_2}\right)$$

$$P_{av} = I_{rms}V_{rms}\cos\phi$$

$$P_{av} = I_{rms}V_{rms} = {I_{rms}}^2 R = \frac{{V_{rms}}^2}{R}$$

$$V = V_{\max}\sin(2\pi ft)$$

$$I = I_{\max}\sin(2\pi ft)$$

$$V_{rms} = \frac{V_{\max}}{\sqrt{2}}$$

$$I_{rms} = \frac{I_{\max}}{\sqrt{2}}$$

$$L = \frac{N\Phi_B}{I}$$

$$L = \frac{\mu_0 N^2 A}{l}$$

$$M = \frac{N\Phi_B}{I}$$

$$M = \frac{\mu_o N_1 N_2 A}{l}$$

$$P_a = I_{rms}^2 Z$$

$$R = R_0\left[1+\alpha(T-T_0)\right]$$

$$R_{TS} = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{R_{TP}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$V_{BA} = V_B - V_A = \frac{W_{BA}}{q}$$

$$U = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

$$u_E = \frac{U}{Ad} = \frac{1}{2}\varepsilon_0 E^2$$

$$\Phi_B = BA\cos\theta$$

$$\varepsilon = -N\frac{\Delta\Phi_B}{\Delta t}$$

$$M_{12} = \frac{N_2\Phi_{12}}{I_1}$$

$$r = \frac{mv}{Bq}$$

$$U = \frac{1}{2}B^2 A\frac{l}{\mu_o}$$

$$U = \frac{1}{2}LI^2$$

$$V_H = Bvd$$

$$X_C = \frac{1}{2\pi fC}$$

$$X_L = 2\pi fL$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$\cos\phi = \frac{R}{Z}$$

$$\tan\phi = \frac{X_L - X_C}{R}$$

$$\oint B.dl = \mu_o I$$

$$q = Ne$$

$$\Phi = EA$$

$$\Phi = \frac{q_{in}}{\varepsilon}$$

$$V_A = \frac{PE_A}{q}$$

$$V = \frac{U}{q}$$

$$\varepsilon = -\mu_0\frac{N^2 A}{\ell}\frac{dB}{dT}$$

$$\varepsilon_2 = -M_{12}\frac{\Delta I}{\Delta t}$$

$$I_E = I_C + I_B$$

$$\alpha_F = \frac{I_C}{I_E}$$

$$\beta_F = \frac{I_C}{I_B}$$

$$C = 2\pi r$$

$$A_{circle} = \pi r^2$$

$$A_{sphere} = 4\pi r^2$$

$$V_{sphere} = \frac{4}{3}\pi r^3$$